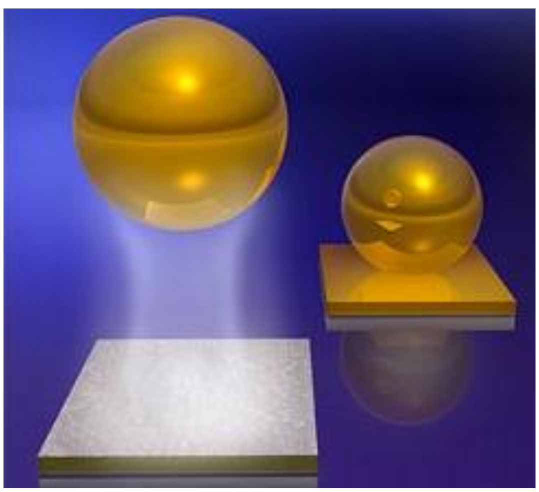
SCIENTIFIC ACCOMPLISHMENTS: FUNDAMENTAL NANOSCALE PHENOMENA AND PROCESSES (PCA 1)

Discovery of Nanoscale Repulsion

Due to the uncertainty principle of quantum mechanics, the constituents of matter never reach a state of absolute rest. Even on a material with no overall electric charge, tiny positive and negative charges fluctuate below directly detectable limits. However, these fluctuating charges can produce minute attractive forces known as Casimir-Lifshitz forces that occur between materials separated by a few tens of nanometers. The Casimir-Lifshitz theory also predicts that the forces can be repulsive under certain circumstances.

Federico Capasso of Harvard University and his colleagues have demonstrated this repulsive force for the first time. To test this part of the theory, the team measured the force between a gold-coated polystyrene sphere and a plate made either of gold or of silica, all immersed in the organic liquid bromobenzene, chosen for its electrical properties. As the gold-coated sphere was brought closer to the gold plate, the researchers measured a tiny attractive force. But when they used a silica plate instead, they found a repulsive force of approximately one ten-billionth of a newton beginning at a separation of about 80 nanometers. The repulsive effect could have value in the functioning of various nanostructures by overcoming friction and sticking between moving components of nanodevices.



When the proper materials are chosen, repulsive Casimir-Lifshitz forces can exist. The image shows one sphere being repelled from a plate and another sphere being attracted.

J.N. Munday, F. Capasso, V.A. Parsegian, "Measured long-range repulsive Casimir–Lifshitz forces," *Nature* **457**, 170 (2009).

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